CONTROLLING BRUSH IN ALBERTA

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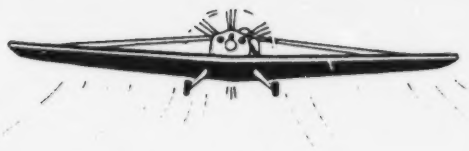

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I. Controlling brush in agricultural areas

Introduction

Brush is an all encompassing term used to describe virtually all woody growth, ranging from western snowberry (buckbrush) and rose species on range in the south, to tall poplars and conifers growing on rights-of-way and pastures in the north. Brush is a natural part of the vegetation in Alberta. Brush control is continuous, but will vary depending upon the acceptable level of control desired by the land manager. This decision should always be made prior to undertaking any brush control operation.

On rangeland, groves of poplar will provide shade and shelter for cattle, however, these groves must be maintained at the desired size, and any regrowth encroaching on grazing land should be ruthlessly controlled. The growth of western snowberry and rose species will severely restrict or even eliminate grass, so control of these species is very important.

In certain cases brush growth may be useful, and in fact essential, and in these cases the landowner must accept the loss of some grass in exchange for other advantages. Brush that grows on steep hillsides will develop a massive underground root system which will prevent erosion of the hillside. Destruction of trees in this situation could lead to serious erosion before ground cover can be established. Trees growing around a spring or a small stream or slough tend to keep such areas from drying up. If water is an asset to the area then trees and brush should not be removed. On the other hand, if the habitat is such that growth of spotted water hemlock (*Cicuta maculata* L.) or larkspur (*Delphinium* spp) is encouraged, then brush should be removed to provide a less suitable habitat.

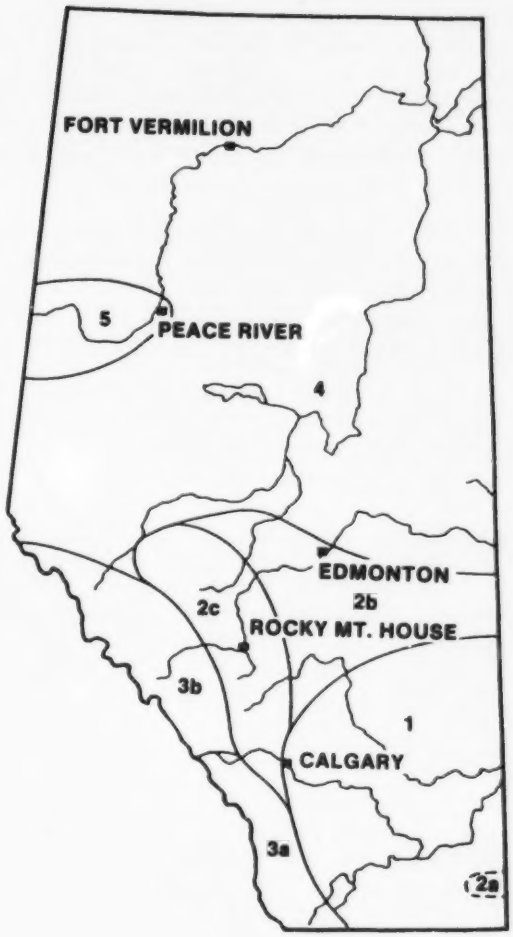
A certain proportion of brush is very useful to act as "snow banking" vegetation to improve the soil moisture supply.

Zones of vegetation in Alberta

The province may be divided into several zones, based upon climate and soil type and the resulting type of vegetation found there.

Zone 1 - Prairie - This zone consists of almost treeless grasslands, with encroaching brush mainly rose species, western snowberry and pasture sage. Larger trees and shrubs such as aspen poplar, balsam poplar, willow, alder, and saskatoons occur almost entirely in deep coulees and ravines.

Zone 2b - Central Parklands - The parklands border on the prairie zone. The central parklands are the more central area and the tree groves are mainly aspen poplar and possibly some willows.



Zone 2c - Western Parklands - The more westerly area bordering the prairie zone. The tree growth is mainly aspen poplar with some willow and balsam poplar.

Zone 3a - Rocky Mountain South - This zone lies between the parkland zone and the mountains. The climate varies sharply with increased elevation. Generally speaking more coniferous growth such as spruce, lodgepole pine, Douglas fir and western red cedar is interspersed with aspen poplar and mixed hardwoods, which are found on less exposed slopes and in ravines.

Zone 3b - Rocky Mountain North - Similar woody growth is found here as in the Rocky Mountain South Zone.

Zone 4 - Boreal Forest - A very large zone situated north of the parkland zone. It is mostly covered with coniferous forest. In the south part the common woody growth is

similar to that found in the parklands, but in the north we find white spruce on the uplands, black spruce on the lowlands and jack pine on the sandy soils. Areas which have been logged over in recent years will be covered with deciduous forest dominated by aspen poplar, balsam poplar and birch. Higher wetlands will have clumps of willows, swamp birch, black spruce and larch interspersed with clumps of labrador tea.

Zone 5 - Peace River - This is a small island in the boreal forest zone. The climate is somewhat warmer and drier and the growth is more similar to that of the parkland area. Woody growth is predominantly aspen poplar, willow, chokecherry, pincherry and saskatoon.

The boundaries between the vegetation zones are not distinct, the brush growth gradually changing. A knowledge of the characteristic growth in each zone will aid in determining the most effective means of control.

Why is brush Removed

- **to increase cropland acreage**
- **to reclaim grassland lost to brush encroachment**
- **to develop more or better pasture**

Clearing forested or brush covered land

Irrespective of the final use to which the land will be put, the initial brush clearing steps are usually the same. The brush must be removed. In some cases the brush will be chemically treated and killed prior to removal. In other cases the brush may be removed first and the regrowth controlled.

One point should be clearly understood - any brush covered area which is cleared and used for pasture will tend to revert to brush cover. If the brush species are unpalatable to the grazing stock, or if it grows rapidly out of the reach of grazing livestock then a brush control program must be developed.

There are no step by step instructions for converting brush covered land to grasslands. Many lines of action are possible and each alternative will have certain advantages and disadvantages. Each landowner must decide which option to choose based upon his own specific conditions and expectations.

Any landowner attempting to convert brush covered land to grassland pasture must realize that continued efforts will be required to maintain the brush under control. Techniques of brush control will vary depending upon the topography and soils of the area. The most successful would be to seed an annual crop suitable for grazing with the alternative of seeding to a harvestable crop (cereal) for a number of years. The annual cultivation and crop spraying for weed control will reduce the brush infestation. When the brush species disappear, seed the area to a perennial forage mixture.

If the area is unsuitable for cultivation because it is too rocky or hilly or too wet, then the only alternative would be to graze the area and treat the brush regrowth chemically.

The more time spent in brush control before seeding a perennial forage mixture the longer it will be before any future brush control action is required.

A landowner wishing to develop a high quality grassland pasture usually has to deal with one of two basic brush problems. The first involves converting forested land to grasslands (prime clearance) and the second involves converting land which was once cleared but has grown back to brush (secondary clearance).

In both cases the initial brush clearance usually requires similar machinery. The size and specific type of equipment is generally dictated by cost efficiency, which in turn will be dictated by a combination of tree size, density and topography of the land. Once the brush is cleared and piled, the next steps are similar, whether dealing with trees or brush.

If the brush is fairly large, more than 6 in. (15 cm) in diameter at the butt, the usual technique is to walk down the trees with a bulldozer and push the debris into windrows. The size of the bulldozer will depend upon equipment availability and the terrain on which it will be working as well as the size of the brush, but usually a D7,

Figure 1. Using a bulldozer and blade to walk down taller brush.

Figure 2. Debris and trees being pushed into windrows.

Figure 3. A brush cutter - pushed ahead of a bull dozer. The wings direct the brush inward and the cutting blade cuts it at ground level.

D8, D9 or equivalent is used. Farmers claim that if poplar is cleared in summer there is a substantially greater root removal than if clearing is done at other times of the year when the ground is not frozen. However, the equipment may not be available for land clearing in August so most brush clearing is carried out after freeze up when the equipment is no longer in demand for other uses and trees and larger brush are usually frozen and very brittle. Less power is required to cut trees when they are frozen than when they are growing.

Brush mowing

Brush mowing is usually done with a seven foot gyro mower. This type of control is best suited to areas of rolling topography where there is no problem with stones. If the brush is only scattered and stems are less than one inch (2.5 cm) in diameter, farm mowers can be used. However, if brush growth is very dense and stems are thicker than one inch (2.5 cm), it is generally more cost effective to use an industrial gyro mower.

Generally, it has been found that mowing poplar regrowth in August will significantly reduce regrowth and will compare very favorably in cost to cutting and then windrowing.

Mowing using an industrial gyro mower is not often done in agricultural situations, probably because industrial type mowers are not as readily available as a bulldozer. Mowers are very comparable in cost to bulldozers. In those areas where mowing can be done, brush piling, burning the brush piles, repiling and reburning are not required.

Once an area has been mowed it is ready to plough or disc.

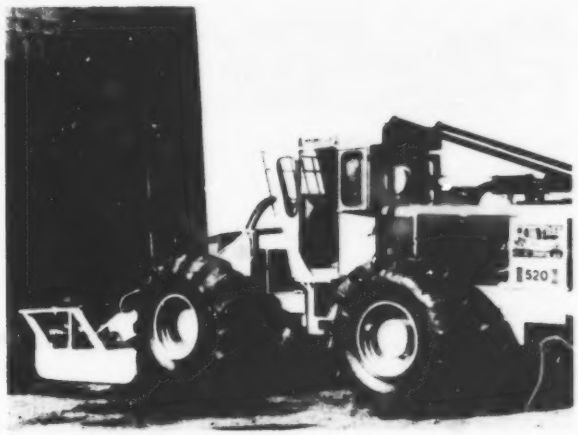


Figure 4. Industrial gyro brush mower.

Windrowing technique

Windrowing consists of a single pass with an angled dozer blade in one direction, followed by a second pass in the opposite direction. It is often used in situations where the reverting growth is dense, ranging up to 26 ft (8 m) in height. This technique is most effective when early winter blading is carried out on land where topographical changes are not severe and where the land is not too stony.

Because of the snow held in the windrows, there will be an early spring flush of forage production. Ideally grazing should be deferred until midsummer to encourage forage establishment and to allow grazing animals to utilize the heavy new sucker regrowth.

When windrowing is carried out it will enable the cost of development to be spread over a number of years, while using the cattle grazing pressure to aid in sucker control.

Windrowing has disadvantages not encountered with brush mowing. With the use of this technique there is considerable soil disturbance as the brush piles are a mixture of brush and soil, which inhibits burning, particularly if the brush is very tall. The initial burn will be much less than complete and it will be necessary to carry out at least a couple of repile and burn operations. In this process the native grass and forb cover is destroyed and weeds and brush will growth.

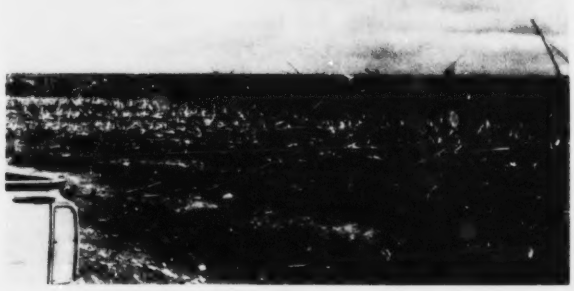


Figure 5. A typical windrowed area showing windrow in the background. A considerable amount of additional work is required before this area will reach an acceptable grazing potential.

Fire as a brush control tool

Considerable interest is expressed in the use of fire to control brush. The impression exists that if a controlled burn is used, there will be no cost involved. This is far from true, since it has been estimated that a controlled burn will involve costs in the range of $50.00 per acre, and the brush or trees may still have to be removed.

Figure 6. Note regrowth from base of various clumps about 3 months after a burn.

Because of the potential problems inherent in the use of fire as a brush control agent **no one should attempt a prescribed burn without reading at least Chapter XVI in the following book:**

H.A. Wright and A.W. Bailey - 1982 -
Fire Ecology - United States and Southern Canada
Published by John Wiley & Sons, New York.
Available from University of Alberta, Book Store, Students Union Building, Edmonton, Alberta T6G 2J7.

Chapter XVI is entitled "Prescribed Burning", and details specific conditions and procedures to follow for a safe, effective operation.

Figure 7. Note weed and brush regrowth from base of clumps about 3 months after a burn.

Alternatives in any agricultural clearing program

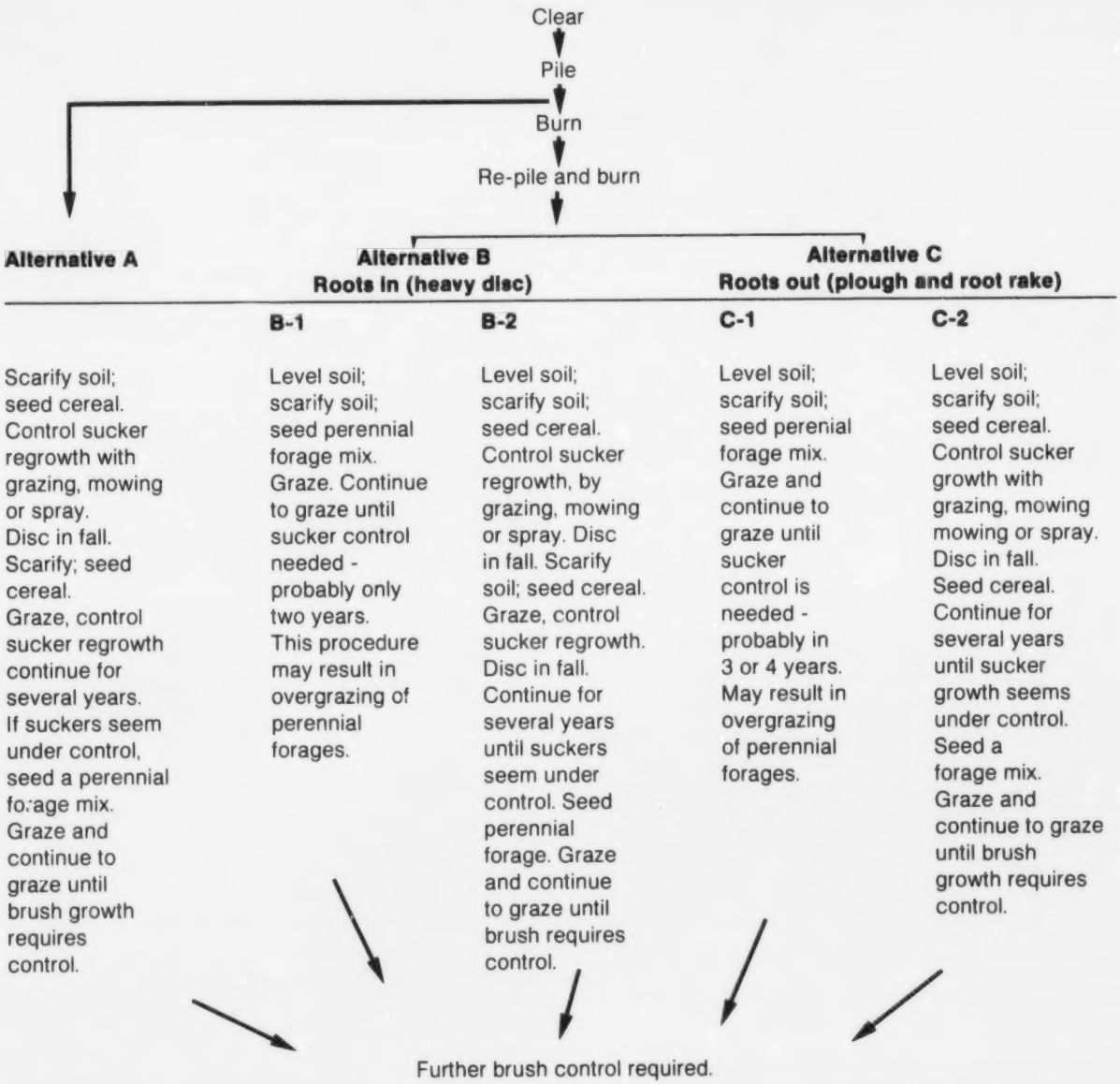
The initial brush control operations described to this point are basically the same whether the area is to be used for grazing or cropping. In all cases the brush must be cleared and removed, either with a brush cutter, or with a bulldozer which will pile the brush ready for burning, repiling and reburning.

Alternative A

This alternative can be used following the initial piling of brush in the windrowing operation.

1. Scarify the soil to provide a seed bed. The implement used for this purpose will need to be fairly sturdy since there will be considerable debris on the ground and the roots will still be there. Establishing a cereal crop will not be successful unless some form of seedbed is produced. Cereals should be seeded into a prepared seed bed. It is essential that the

Alternatives in any Clearing Program


Clear
Pile
Burn
Re-pile and burn
Alternative A
Alternative B
Roots in (heavy disc)
Alternative C
Roots out (plough and root rake)
B-1
B-2
C-1
C-2
Scarify soil; seed cereal. Control sucker regrowth with grazing, mowing or spray. Disc in fall. Scarify; seed cereal. Graze, control sucker regrowth continue for several years. If suckers seem under control, seed a perennial forage mix. Graze and continue to graze until brush growth requires control.
Level soil; scarify soil; seed perennial forage mix. Graze. Continue to graze until sucker control needed - probably only two years. This procedure may result in overgrazing of perennial forages.
Level soil; scarify soil; seed cereal. Control sucker regrowth, by grazing, mowing or spray. Disc in fall. Scarify soil; seed cereal. Graze, control sucker regrowth. Disc in fall. Continue for several years until suckers seem under control. Seed perennial forage. Graze and continue to graze until brush requires control.
Level soil; scarify soil; seed perenial forage mix. Graze and continue to graze until sucker control is needed - probably in 3 or 4 years. May result in overgrazing of perennial forages.
Level soil; scarify soil; seed cereal. Control sucker growth with grazing, mowing mowing or spray. Disc in fall. Seed cereal. Continue for several years until sucker growth seems under control. Seed a forage mix. Graze and continue to graze until brush growth requires control.
Further brush control required.

seed be lightly covered with soil [never more than 1 in. (2.5 cm)] to ensure good germination and establishment. Because of rough terrain, debris and stones, it is unlikely that it will be possible to use a drill of any type, therefore broadcast seeders are usually used. The common implement used to cover the annual forage seed is a set of drag harrows, or if there are too many roots for this type of equipment just drag a small log behind the tractor. Any equipment which places a light covering of soil over the seed is satisfactory. Regrowth of brush from the roots left in the ground will begin the year following clearing. Grazing pressure will control some of this brush regrowth, but it is false economy to depend upon grazing for complete control. Application of a registered chemical in the early summer of the second growing season following clearing, combined with summer grazing and a fall disking will, after several years, bring brush regrowth under control.

If cereals are seeded each summer, it is possible to use common and relatively inexpensive herbicides, such as 2,4-D or dicamba, to control brush regrowth without a serious reduction in the quantity of cereal top growth. If dicamba is used each year there may be some injury to barley crops. Wheat and oats are very tolerant.

After operating this program for several years it will be apparent that the roots are beginning to rot and the regrowth is becoming less vigorous. Once this stage has been reached serious consideration should be given to seeding a perennial forage mix. Legumes should not be seeded until all need for chemical brush control has passed. A chemical application will effectively remove most of the legumes from the forage stand.

Any action which weakens the forage stand, such as overgrazing or a serious reduction in fertility — which should be checked by a soil test, will allow the invasion and establishment of brush. The major advantage of following this alternative is that the area being cleared will be producing annual forage all the time that burning, repiling and reburning are taking place.

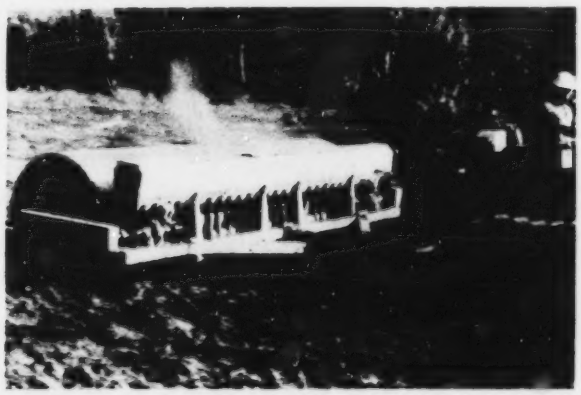


Figure 8. PFRA drill seeding a forage mix.

Alternative B - "roots in" technique

This technique involves several passes with a heavy breaking disc followed by one or two passes with a light working down disc prior to seeding. This can be done between brush piles, or ideally, may be delayed until after the brush piles are burned. The most effective method of disking would be to carry out each operation at right angles to the preceding one.

A heavy breaking disc weighs 500 to 550 lb/foot, is usually 10 feet in length and has discs 32 inches in diameter, spaced 6 to 9 inches apart. It should be pulled by a 300 HP plus tractor, or a D7 or equivalent bulldozer. A lighter working down disc weighs 400 to 450 lb/foot and requires slightly less horse power to handle, approximately 250 to 300.

B-1

Most of the stumps and roots are left in the soil and for this reason there is heavy suckering and brush regrowth with this technique. The method of controlling heavy regrowth will depend upon the stage at which this control begins. It may involve i) windrowing regrowth, ii) mowing and reseeding to annual forages with an annual fall disking, or iii) the application of a chemical brush control agent. It is always easier to control brush regrowth when it is young and still small. Once it appears that the brush regrowth has been reduced to manageable proportions, (brush cover less than 1 per cent of ground cover), then it is practical to consider seeding to a permanent forage mix. Prior to seeding, disc once or twice with the heavy breaking disc, level with a working down disc and pack with a land roller. After several heavy diskings the soil will be very loose, and most seedling problems can usually be traced back to this condition. Ensure that the seed is lightly covered [never more than 1 in. (2.5 cm)] either in the seeding operation or by a light harrowing after seeding. Light grazing is essential since a vigorous forage stand will lead to reduced brush regrowth.

Comments

In using this technique light grazing is possible within the year of clearing and some of the regrowing brush may be nipped off by the cattle. Such an operation is practical where the terrain is reasonably level and a heavy breaking disc and adequate power to pull it are readily available.

B-2

The most effective means of reducing brush regrowth is to spring cultivate, seed a cereal and harvest it as forage or grain, fall disc or cultivate, and seed again in the spring. The fall disking will serve to reduce the root suckering substantially. Continue this practice for several years until the problem of brush regrowth is greatly reduced, and then seed to a perennial forage. This will lengthen the time until another full scale brush control program will have to be initiated. This control practice is only possible on level to slightly rolling terrain which permits normal cultivation.

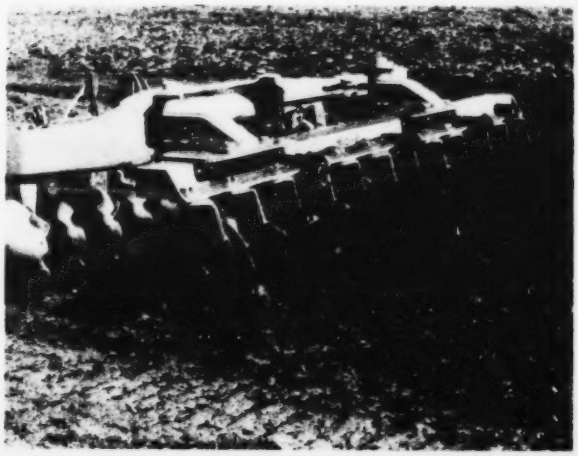


Figure 9. Breaking disc in operation.

The landowner must have suitable equipment to cultivate the land and harvest the crop. The advantages of following this alternative are, i) as long as the cultivation program is followed, good control of brush will be maintained, and ii) income from annual crops will underwrite some of the costs of land clearing and brush control. The disadvantages are, i) if development of additional pasture is the final objective, a longer period is necessary before the pasture is in full use, and ii) this option may be exercised only if cultivation is feasible.

Alternative C - "roots out" technique

This technique generally entails the use of a heavy duty breaking plough, drawn by a heavy tractor or D7 bulldozer or equal, or a 300 HP plus tractor and followed by one or two passes with a root rake. This will usually remove most of the brush and tree roots and reduce the potential for brush regrowth, but it tends to bury nutrient rich topsoil and replace it with the subsoil. In the Gray Luvosolic soils it may lead to crusting of the soil surface and poor emergence of seeded forage. Instead of a heavy duty breaking plough, a rotovator may be used.

C-1

This alternative technique involves levelling the soil after root raking, harrowing or scarifying the soil, by some means and seeding to a perennial forage.

Figure 10. Breaking disc into operation.

Figure 11. Breaking plough in operation.

To ensure a successful forage stand, it may be necessary to apply a fertilizer mixture. This mixture should invariably contain phosphorous and perhaps nitrogen. See *Alberta Forage Manual* - Agdex 120/20-4 available from Alberta Agriculture district extension offices.

As soon as the perennial forages are well established, grazing can begin. Since perennial forage mixtures usually contain some legumes, no chemical brush control will be possible. However grass forage is often quite slow in getting established and brush regrowth could take over. The advantage of this alternative is, i) grazing is possible with a lower financial investment, and ii) heavy grazing of this area may provide some control of the brush regrowth.

There are many disadvantages: i) because of early seeding after minimum tillage, brush regrowth will be very heavy, ii) attempting to control the brush by grazing will result in overgrazing of the perennial forage and will shorten the effective life of the pasture, iii) with the overgrazing of the perennial forages and the reduction in the vigor of their stand, a rapid increase in brush regrowth usually occurs and since grazing to control brush will also overgraze perennial forage stands, this can be a self-defeating operation.

C-2

This alternative could be classed as the best long term treatment. Short term costs are high but long term averages are more acceptable.

Following ploughing, root raking and root picking the soil is levelled by harrowing or cultivating, packed with a heavy roller and seeded to an annual crop.

Figure 12. Rotovator.

As an alternative to the breaking plough a rotovator may be used. The rotovator provides a good seed bed but is usually more expensive to operate and will still require root raking and root picking prior to levelling, packing and seeding.

A rotovator often used is 10 feet wide, self powered and drawn by a four wheel drive tractor in the 350 HP range or a bulldozer of equivalent power.

This sequence of seeding an annual cereal or grass forage, chemically treating brush regrowth during the growing season, disking and preparing a seed bed the following year and seeding to an annual cereal or grass forage should be continued until the brush regrowth appears under reasonable control (less than 1 per cent of the ground cover). This could well require four or five years before annual crops can be replaced by a perennial forage or a cereal rotation may be undertaken. If perennial forages are seeded, managed grazing should continue until brush becomes a problem and a major renovation is again required.

Considerations useful in choosing your techniques

Alternative A (seeding between windrows)

Advantage

- Grazing or forage may be produced between the windrows while burning, repiling and reburning take place.
- If grass forages are seeded, chemical brush control is possible.
- In areas where cultivation is not possible, it is the only effective means of establishing growth.

Disadvantage

- It is a relatively ineffective means of controlling brush.
- Major brush control is essential within a few years.

Alternative B - roots in technique

B1 - seeding forage between windrows after passes with a working down disc.

Advantage

- Grazing or forage may be produced within the year of clearing.
- If grass forages are seeded, chemical brush control is possible.
- Work may continue in burning, repiling and reburning of windrows.
- Some brush may be nipped off by grazing animals.

Disadvantage

- A heavy breaking disc and adequate pulling power must be available.
- It is most efficiently carried out in areas of level and nonrocky terrain.
- Brush regrowth will compel early, major brush control operations.

B2 - seeding and harvesting an annual cereal crop between windrows for several years.

Advantage

- Annual seed bed preparation, in-crop spraying and harvesting will discourage brush regrowth.
- Annual return from marketing cereals or forage will aid in payment of costs of clearing.
- Because of better brush control before perennial pastures are seeded, more years will pass before a major brush control program must be initiated.

Disadvantage

- If developing additional pasture is the final objective a long period of time will elapse before the pasture is in full use.
- This option may only be exercised if cultivation is feasible, and if the landowner has available the necessary cultivation and harvesting equipment.

Alternative C (roots out technique)

C2 - use breaking plough, root rake, root picker, harrows, packer and seed to perennial forage.

Advantage

- A high percentage but not all the roots are removed.
- Early, managed grazing is possible.
- The land is better prepared for production of harvestable crops.
- Brush is usually better controlled by annual cultivation and in-crop spraying.
- Provides the landowner with an alternative: seeding perennial forages or continuing to grow annual crops.

Disadvantage

- The initial out of pocket cost is high.
- Erosion may be a problem under certain conditions.

General considerations - all options

The most important factor affecting final land usage is the extent of brush regrowth following development. Any action to reduce this potential regrowth must be carefully considered in the early stages of development.

Actions, such as delaying breaking until late summer, preferably August, are seen to reduce suckering. Production of an annual crop with an annual working down for several years will reduce suckering.

The topography of the land must be such that intensive cultivation is possible and this intensive cultivation should not pose problems of erosion.

Figure 13. Breaking plough.

Annual hay or silage

For current varietal information consult the annual publication - *Varieties of Annual Forage Crops for Alberta* - 120/32-1, available from Alberta Agriculture district extension offices.

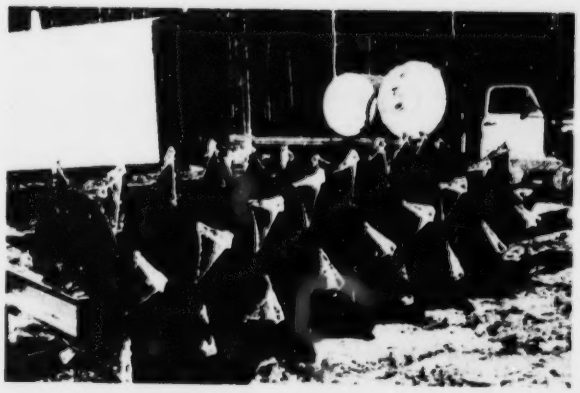


Figure 14. Root picker.

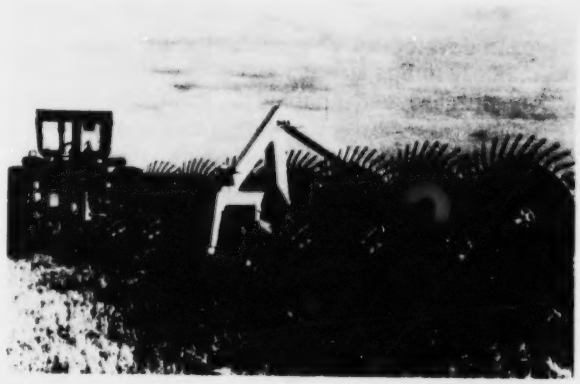


Figure 15. Root rake.

Seeding annual forages

Broadcast seeding following clearing and piling of brush usually has very limited success. It should only be considered where the land is very stony or rolling, or has moisture restrictions, or where there is a pressing economic need for immediate grazing, or where some other factor makes this type of seeding necessary.

No matter when seeding is done or what is seeded, the seed must come into contact with mineral soil to successfully germinate and become established. A light scarification of the soil surface will provide a six to eight fold increase in forage establishment.

General comments - annual forage and pasture crops

- Select the crop to be seeded first, then choose the variety. Barley and oats produce pasture early in the season, oats provide some regrowth for later use. Winter wheat, fall rye and winter triticale produce less of their total yield early in the season, but regrow well throughout the summer.

- Annual pastures are best suited for emergency and short term use, but properly managed can extend the grazing season. Animals should be gradually introduced to the pasture and strip grazing will reduce wastage. The yearly costs of an annual pasture over the long term are generally higher than for perennial pastures.
- Mineral supplementation is essential.
- Annual pastures may pose the problem of nitrate toxicity if soil nitrogen levels are high and the crop is under stress.

Perennial forages

For current varietal and establishment information consult the annual publication - *Varieties of Perennial Hay and Pasture Crops* - 120/32 - available from Alberta Agriculture district extension offices.

Steps in developing a perennial forage stand

1. Choose forage species that germinate readily, are competitive and adapted to local site, soil and climatic conditions. If chemical spraying of brush is contemplated in the near future, there is little advantage to seeding a forage mixture containing legumes.
2. The surface disturbance of the soil caused by brush piling often creates a good seedbed for new pasture between the piles, especially if it can be seeded during or immediately after brush piling. If several diskings have provided a very loose seed bed, packing may be necessary. To avoid crusting **do not pack** heavier textured Gray Luvosolic soils.
3. Scarify soil with harrows or disc just before seeding to improve seeding establishment; a light harrowing after seeding will just cover the seed.
4. Seeding rates for the forage mixture should be increased to one and a half to twice the normal recommended rate to compensate for the seedling mortality which normally occurs.
5. Do not graze new seeding until it is well established.
6. Do not be too quick to call a new seeding a failure.

Comments on early seeding to perennial forages

Early seeding to perennial forages almost always results in a lower quality pasture because of the heavy weed invasion and the high proportion of native forages which invade the stand.

However, recent studies conducted by Agriculture Canada, Lethbridge, have indicated that weeds such as lamb's-quarters, flixweed, kochia, stinkweed and wild oats are a reasonably good source of nutrition.

Generally speaking, pasture longevity will be seriously reduced because of heavy brush regrowth, unless an effective control program is undertaken. However, chemical brush control will remove all legumes from a perennial forage mixture. This presents a problem because a legume - grass mixture will produce double the yield of a grass pasture.

Soil tests will monitor soil fertility and will indicate when fertilizing is necessary.

Summary

No single technique is best in all situations. Usually a combination of techniques should be employed, based upon starting conditions and the final result desired.

No matter which alternative is selected to convert brush or forest covered land to grazing land, skilled management will be constantly required to ensure that it does not quickly revert to brush. Almost certainly such land will eventually require some form of brush control again, but proper management will extend the intervening period.

Brush control as a pasture maintenance tool

1. **Mechanical**

   A gyro mower or even a swather or farm mower may be used to cut sucker growth. The type of equipment used will depend upon the height and density of the brush. If the terrain is very rough or has many protruding rocky outcroppings or tall heavy stumps, it is not likely that a gyro mower can be used.

   It has been found that routine brush cutting during summer (July, August) for several successive years will provide a final good brush kill. Cutting during the winter (September to April) period will provide a relatively poor kill of brush.

2. **Biological**

   Cattle will graze young aspen and willow regrowth and aid in control of these species, but suckers of black poplar will be avoided, and these suckers grow very rapidly and may become a problem.

3. **Chemical**

   Very few chemicals are registered for use in pastures. Dicamba, 2,4-D, and combinations of these two are the only materials registered at this time to control brush in pastures. Grazing restrictions following the use of dicamba may apply. It is not possible to provide an exact per acre rate of solution mix to apply, since the size and density of brush will vary widely from one acre to the next. The usual recommendation reads, "spray brush from all sides to the point of run-off", and the mix is quoted in litres of concentrate per 1,000 litres of water or solvent.

Chemical mixes registered for use in pastures

Problem Weed or Brush Growth	Banvel LH		2,4-D Amine 500	2,4-D Ester 600
Canada thistle Field bindweed Goldenrod Tansy ragwort	850 mL/ac (2.1 L/ha)	PLUS	900 mL/ac (2.2 L/ha)	
		OR		
Perennial sow-thistle	850 mL/ac (2.5 L/ha)		PLUS	750 mL/ac (1.85 L/ha)
Diffuse knapweed Spotted knapweed Poverty weed Pasture sage Thyme - leafed spurge	1.85 mL/ac (4.6 L/ha)			
Aspen poplar	1.3 L/ac (3.25 L/ha)	PLUS	1.8 L/ac (4.4 L/ha)	
		OR		
	1.3 L/ac (3.25 L/ha)		PLUS	1.5 L/ac (3.75 L/ha)
Rose spp	1.50 L/ac (3.65 L/ha)	PLUS	1.8 L/ac (4.4 L/ha)	
		OR		
	1.50 L/ac (3.65 L/ha)		PLUS	1.5 L/ac (3.75 L/ha)
Western snowberry	1.5 L/ac (3.65 L/ha)	PLUS		1.5 L/ac (3.75 L/ha)

NOTE: Since the exact rate of solution laydown on a per acre basis cannot be specified for controlling brush, an arbitrary rate of 200 L/ac has been selected. The per acre rates shown should be mixed in 200 L of water.

Precautions

1. For the latest recommendations for chemical brush control, consult the current *Guide to Crop Protection in Alberta - Part I - Chemical* Agdex 606-1 - available from Alberta Agriculture district extension offices.
2. If Banvel LH is used at the 7.5 L/1000 L rate or more and applied on less than two acres, do not feed or allow dairy cattle to graze the treated area for 30 days.

   Meat animals may graze Banvel LH treated vegetation 30 days after treatment, with no restriction on slaughter.
3. Concentration and rate of application of mix must be varied depending upon the species of brush and the height and density. Adequate coverage is essential.

For detailed comments on chemicals mentioned refer to page 17 and following.

II. CONTROLLING BRUSH IN NONAGRICULTURAL AREAS

Generally speaking, industrial areas such as municipal roadsides, power corridors, pipeline and railway rights-of-way have had the primary brush cover removed at the time of development.

Following right-of-way establishment, brush must be continually controlled in order to maintain an efficient operation of the utility in question.

Why control brush

The reasons for controlling brush vary with each situation.

1. **Municipal roadsides**
   - to aid drainage from road surfaces and to keep ditches clear to drain water from the road and from adjacent farmland,
   - to make winter snow removal easier and more efficient
   - to increase visibility at corners, rail crossings and school bus stops
   - to remove or at least reduce a wildlife habitat and reduce the danger of vehicle wildlife collisions.
2. **Transmission line corridors**
   - to eliminate the possibility of power outages or fires if trees contact a power line
   - to provide a convenient and safe access and working area in the event repairs are required.
3. **Pipeline rights-of-way**
   - **to eliminate all woody growth in a relatively narrow band directly over the pipeline. Patrol of pipelines is normally made by air and in order to spot leaks it is essential that there be no tall woody growth**
   - **to provide a convenient and safe access and working area in the event repairs are required.**
4. **Railway rights-of-way**
   - **to aid drainage from the ballast section and to keep the ditches clear to drain water away**
   - **to make winter snow removal easier and more efficient**
   - **to increase visibility at rail crossings and at operating signals and make railway operations safer**
   - **to reduce wildlife habitat and reduce the danger of locomotive wildlife collisions**
   - **to reduce interference of tall brush with lines carrying railway signals.**

Rules for application of chemicals

The Industrial Vegetation Management Association of Alberta, composed of representatives of industry and government has drawn up a set of guidelines. The guidelines are subscribed to by all members of the association and will bear consideration by all operators planning to carry out this work.

Rules of procedure

1. All chemical applications shall be made by, or under the supervision of, qualified, licensed applicators.
2. There will be no brush spraying under any of the following conditions:
   a) within 30 horizontal metres of the boundary of a municipal, provincial or national park, except where specific permission has been granted
   b) in any urban or resort area
   c) within reasonable distance of a dwelling
   d) on private property, including Indian reserves, without first obtaining permission
   e) within 30 horizontal metres of open water, unless a permit has been obtained from Alberta Environment
   f) areas near gardens, planted trees, or susceptible field crops will be left for either:
      i) knapsack spraying, or,
      ii) dormant (off season) spraying, or,
      iii) mechanical control
   g) a 30 metre buffer strip will be left wherever a main transmission powerline or pipeline crosses a numbered highway.
3. Maximum tree heights allowed for a herbicide treatments are as follows:
   - 1.5 metres on any right-of-way that shares a common right-of-way boundary with a numbered highway.
   - 2.5 metres on any right-of-way that shares a common right-of-way boundary with a paved road, main market or gravelled road.
   - 4.0 metres in any right-of-way that goes cross country.

NOTE: *In instances where areas of higher trees are allowed to be sprayed, mechanical removal must take place prior to the following growing season.*

4. All vegetation control operations must be carried out in conformity with the acts and regulations promulgated by the government of the province of Alberta.

   Without in any way limiting the generality of the foregoing, special attention shall be paid to:

   - obtaining pesticide permits from Alberta Environment before spraying in the Green area
   - notifying all relevant government offices and departments, as required by the departments involved, prior to commencement of spraying
   - when spraying in counties, municipal districts,

and improvement districts, notification of the agricultural fieldman is requested as a courtesy.

NOTE: *Caution must be observed when parking spray units, especially when it is for a term longer than overnight, and especially in urban settings. By being prepared for the worst, problems will likely be avoided (e.g. keep all valves locked shut and keep all chemicals locked away).*

Use extreme caution in the application of soil sterilants to avoid physical movement and drift of the herbicide beyond the target area.

Maintaining brush control in industrial areas

In virtually every industrial situation the primary clearance of brush is similar to the primary clearance on agricultural land. The prime clearance implement is an adequately sized bulldozer (D7 to D9 or equivalent) and the debris is pushed into windrows or brush piles and burned at an appropriate time.

Brush can be controlled in industrial areas by two means:

Mechanical

A rotary brush cutter or gyro mower may be operated every two or three years or whenever the brush regrowth reaches 4 to 6 feet (1 to 2 m) in height. If the terrain is hilly or with large rocks or rocky outcroppings, mechanical brush cutting will be slow and costly and results will be erratic.

Side trimming

There are situations where, for aesthetic reasons, trees or brush must not be removed. The alternative is pruning or side trimming. This operation requires a high level of expertise, acquired only after extensive training and experience, and requires fairly sophisticated equipment.

Training courses are provided by various utility companies to ensure safe action when side trimming is required in their particular situation. This type of brush control is usually done in highly visible locations; the best equipment and most highly trained operators should be used.

Chemical

Generally speaking this is the preferred method of control because of its effectiveness and the relative ease of applying it. Timing of chemical treatments is important to ensure proper root kill with the minimum chemical rate. Usually a delay of two or three years after primary clearance will allow the development of regrowth to a height of 4 to 6 feet (1 to 2 m). Complete coverage of this foliage with the registered spray solution will provide a very satisfactory kill of both the roots and top growth of many root suckering species such as the poplars and willows.

Chemical application for brush control

Ground application

With all foliage active materials, adequate coverage of the entire target plant is essential for control. This may well involve the application of relatively high volumes of water. Depending upon the height and density and consequent leaf area to be treated, when using ground equipment application rates of 1000 to 1500 L/ac (220-330 gal/ac) are not uncommon.

Aerial application

Because of rough terrain or brush density or accessibility problems, using ground equipment is not always possible. In such cases the only alternative is aerial application. However, with aerial application the advantages of easier accessibility and the probable lower per acre cost of application are often achieved at the cost of poorer final brush kill. Most aerial applicators are equipped to apply no more than 18 to 23 L/ac (4 to 5 gal/ac). With such low application rates adequate coverage of tall, dense brush is difficult to attain. Application rates may be doubled and coverage greatly improved by turning and respraying the same swath in an opposite direction. This will, of course, add to the application cost, but results will be greatly improved.

NOTE: *In all cases, whether application is by air or by ground equipment, follow up inspections to determine the amount of regrowth will be necessary. The requirements of each situation will determine when retreatment will be necessary. The best final kill is usually obtained if the retreatment is carried out before surviving brush has had a chance to fully recover from the initial treatment.*

In the case of ground applications, spot treatment of regrowth with a resultant decrease in the volume of spray solution used per acre may be possible. However, the cost of application is unlikely to be greatly reduced.

In the case of aerial applications, retreatment on a spot basis is seldom possible. A full treatment at full registered chemical rate will be necessary.

Foliage sprays

Generally speaking adequate coverage of foliage during the period of active growth of the brush following full leaf development will provide best final kill. Depending upon the location within the province this will probably be June 10 to July 20. These dates vary from year to year, depending upon the growing conditions, and are quoted only as a guide. Spraying brush after this period of active growth will be less effective. It has been claimed that for each week or 10 days that spraying is delayed beyond the optimum period, there will be a reduction of about 10 per cent in the final brush kill.

Within limits it is possible to compensate for this

reduction in kill by increasing the concentration of the spray solution. If spraying is done after the active growing season, increase the concentration by 5 to 10 per cent for each 10 day period that has elapsed.

The limiting factor is that by late August the foliage is hardening off and the abscission layer has formed prior to leaf drop. At this time there is minimal translocation from the foliage to the roots and the only means of absorption into the roots and into the plant is through the stem, which is not an efficient route.

Another limiting factor is that every product used for brush control has a labelled and registered maximum rate, beyond which herbicide cannot be legally applied. It may thus be impossible to compensate for later season spraying entirely.

Dormant season treatments

Overall spray

If for some reason foliage spraying of deciduous brush cannot be completed during the active growing season, it is possible to spray after leaf fall. In the case of brush less than 8 feet (2.5 m) high, mix an ester formulation of the herbicide, for example **2,4-D Ester 600**, at a rate of **1 part in 19 parts of fuel oil, diesel oil or kerosene** and spray to adequately cover all exposed bark. Top kill may be expected to be reasonably good but the cost will be high.

The season of application of an overall oil based spray is important. Sap movement within the brush generally continues over the entire year, but during October, November and December sap flow is generally downward into the roots. During February, March and April movement appears to be generally upward from the roots. This is the probable explanation for observing better results following an October to December application.

Basal bark treatment

This very labor intensive method of brush control is only effective on deciduous brush. When used to kill large individual trees prior to cutting, it prevents root suckering. The chemical mix used is identical with that described for **Overall Dormant Season spray**. It is applied in such a way as to thoroughly cover all bark up to breast height and to concentrate on the root crown, where the suckers arise.

Stump treatment

After deciduous brush or trees are cut there appears to be almost an explosion of sucker growth. It is of course possible to allow this sucker growth to develop for one or two years and then spray, however, there are occasions when it is desirable to eliminate all sucker regrowth.

Prepare a mix of 1 part of an oil miscible herbicide, example **2,4-D Ester 600 in 9 parts of fuel oil, diesel oil or kerosene**. Spray this mix over the cut surface of the stump, allowing it to cover the entire top and run down the sides and contact the buds at the root crown, from which suckers arise.

This operation **must be done within hours of cutting**, before a callus can form. All stumps must receive treatment or suckers will arise and this means the area must be clear of debris so no stumps are shielded.

This is a costly operation, the chemical mix is expensive and application is very labor intensive, but results are quite positive.

Species Response to Mechanical Clearing and Susceptibility to Herbicides

Trees and Shrub Species	Resprouting Following Mechanical Clearing	2,4-D	2,4-D + 2,4-DP	Dicamba + 2,4-D	Picloram + 2,4-D
		Aerial Application		Ground Application	
Aspen poplar	Yes	Yes	Yes	Yes	Yes
Balsam fir	Yes	No	Inter	Yes	Yes
Balsam poplar	Yes	No	Inter	Yes	Yes
Beaked hazelnut	Yes	Yes	Yes	Yes	Yes
Black spruce	No	No	Inter	Yes	Yes
Bracted honeysuckle	Yes	Yes	Yes	Yes	Yes
Buckbrush or Western snowberry	Yes	Inter	Yes	Yes	Yes
Canada buffaloberry	Yes	Inter	Yes	Yes	Yes
Chokecherry	Yes	Yes	Yes	Yes	Yes

cont'd on page 15

Species Response to Mechanical Clearing and Susceptibility to Herbicides *cont'd*

Trees and Shrub Species	Resprouting Following Mechanical Clearing	2,4-D	2,4-D + 2,4-DP	Dicamba + 2,4-D	Picloram + 2,4-D
		Aerial Application		Ground Application	
Green alder	Yes	Yes	Yes	Yes	Yes
Jack pine	No	No	Inter	Yes	Yes
Lodgepole pine	No	No	Inter	Yes	Yes
Low bush and high bush cranberry	Yes	Yes	Yes	Yes	Yes
Pin cherry	Yes	Yes	Yes	Yes	Yes
Red osier dogwood	Yes	Yes	Yes	Yes	Yes
Rose spp	Yes	No	Inter	Yes	Yes
Saskatoon	Yes	Yes	Yes	Yes	Yes
Swamp birch	Sometimes	Inter	Inter	Yes	Yes
Tamarack	No	Inter	Inter	Yes	Yes
White spruce	No	No	Inter	Yes	Yes
Willow	Yes	Yes	Yes	Yes	Yes
Wolf willow	Yes	Inter	Inter	Yes	Yes

No - Not killed by repeated applications at recommended rate.
Inter - Injured by a single application at recommended rate. Final kill will require repeated applications at recommended rate.
Yes - Killed by a single application at recommended rate.
From: *Alberta Tree and Shrub Identification Guide*, Industrial Vegetation Management Association of Alberta.

Herbicide application equipment

Application equipment is usually specially designed and built for specific purposes. To handle special problems and special terrain experience is required.

Certain basic concepts are common to all situations, such as tanks, pumps, controls and nozzles. For details refer to Alberta Agriculture publication - Guide to Weed Control in Alberta - Part III - Herbicide Application Equipment - Agdex 744-5.

Figure 16. Aircraft applying brush control chemicals.

Figure 17. Municipal Roadside Sprayer - designed to apply weed and brush control chemicals with accuracy and a minimum of drift.

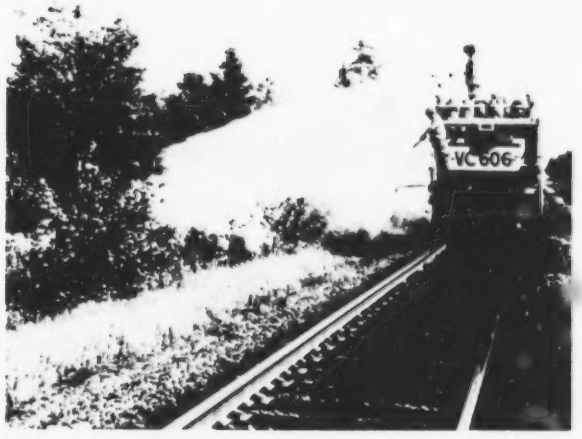


Figure 18 & 19. Two different types of on-rail application equipment designed to treat right-of-way weed and brush growth.

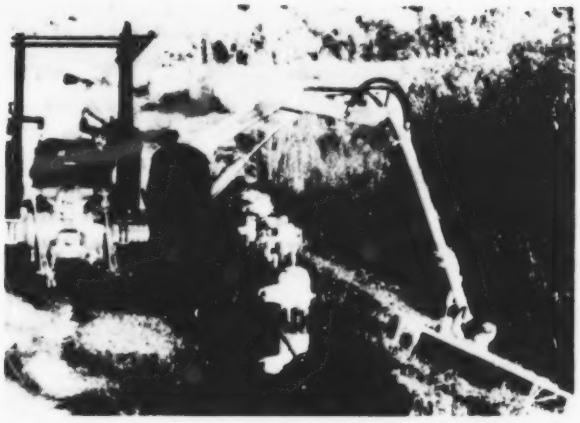


Figure 20. Light weight rotary brush cutter suitable for cutting weeds and brush, up to 2 inches in diameter.

Steps in choosing a chemical brushkiller

1. Identify the problem brush species.
2. Using the chart "Susceptibility to Herbicides" choose a chemical or chemicals which will control your problem brush.
3. Check that the product and formulation chosen are in fact registered for the proposed usage (see following listing).
4. Ensure that mechanics of application, such as volume of solution required, and maintenance of the mix are within the limits of the equipment available.
5. Ensure that any application restrictions are possible without interfering with the desired result.

Registered status - brush control chemicals

1. Registered to control brush in pastures and grasslands: 2,4-D, Banvel LH, Banvel + 2,4-D.

2. Registered to control brush in industrial and noncrop areas: 2,4-D Industrial (Esteron 600, Formula 40) dicamba (DyCleer LH), dicamba + 2,4-D (DyCleer 2:4) dicamba pellets (Banvel 10G), 2,4-D + 2,4-D P (Desormone 7, Diphenoprop 700, Silvaprop 700), picloram pellets (Tordon 10K), picloram + 2,4-D (Tordon 101) fosamine (Krenite).

2,4-D (Industrial)

(Dow)

1. FORMULATIONS: **Esteron 600** - emulsifiable concentrate containing 565 g/L active 2,4-D (low volatile ester). Available in 20 L containers.
   Formula 40F - Contains 470 g/L of active 2,4-D (amine salts) Available in 20 L containers.

2. REGISTERED MIXES: Esteron 600 -with diesel oil, fuel oil or kerosene
   - with above oils and water (addition of a surfactant may be required)

3. CROPS: Registered to control a wide range of weeds and brush growing in noncrop or industrial situations.

4. WEEDS CONTROLLED: Many annual and biennial weeds are controlled. Brush species such as alder, aspen poplar, birch, cherry, elm, hazel, sumac, Manitoba maple and willow are controlled.

5. WEEDS SUPPRESSED: Canada thistle, perennial sow-thistle, field bindweed, horsetail, leafy spurge, and balsam poplar.

6. WHEN USED: For best control of a range of weeds and brush treat while they are young and actively growing.

   Fall treatment of weeds prior to a killing frost will provide good kill.

   Top kill of brush may be slightly enhanced if the mixtures of Esteron 600 with oil and water are applied through August as the foliage becomes more mature.

   Mixtures of Esteron 600 with oil may be applied as a dormant season spray after leaves fall until the snow becomes deep - usually October, November and December.

   This mixture of Esteron 600 plus oil may also be used as a stump treatment - applied to stumps **immediately** after they are cut at any time of the year. To be effective, application must be completed within hours of cutting.

7. HOW TO APPLY:

   With: Aircraft or ground equipment
   Rate: For special applications see "Dormant Season Overall Spray" and "Basal Bark Treatment" and "Stump Treatment"

Formulation	Use	Chemical Rate	Water Rate	Oil Rate
Esteron 600	Summer foliage	8 L	1000 L	—
	Later season foliage	8 L	912 L	80 L
Esteron 600	Dormant season, Basal bark, Stump	30 L		970 L
Formula 40	Summer foliage	8-9 L	1000 L	

   Water Volume: A drenching spray to provide complete coverage of all foliage, shoots and stems. This may require large volumes of spray mix.
   Pressure: 275 kPa
   Ground Speed: Regulate speed to provide adequate coverage.
   Nozzles: High volume OC nozzles or hand gun nozzle to provide adequate volume and coverage.

8. SPRAYING TIPS: Apply in an adequate volume of water and in such a way as to ensure thorough coverage of foliage and stems.

9. HOW IT WORKS: This hormone type herbicide causes abnormal growth symptoms and affects respiration, food reserves and cell division in all broad leafed plants. It is absorbed primarily by leaves and stems and is translocated to the growing tips and roots.

10. EXPECTED RESULTS: Susceptible plants wilt, become malformed and die.

11. EFFECTS OF RAINFALL: A rain free period of 2 hours is required after the application of Esteron 600 and 4 hours after the application of Formula 40.

12. MOVEMENT IN SOIL: There is no problem from leaching.

13. GRAZING AND CROPPING RESTRICTIONS: Do not allow spray drift over desirable areas of susceptible vegetation. No restriction on following seeded crops.

14. TOXICITY: Moderately acute toxicity, some formulations may cause skin irritation. Some formulations are toxic to fish.

15. PRECAUTIONS, FIRST AID: Wear standard protective clothing and goggles to reduce exposure. To clean skin or eyes wash copiously with clean water. If amine formulations are swallowed, induce vomiting, but not if ester formulations are swallowed. Always see a doctor.

16. STORAGE: Amine formulations should not be frozen, but if they are, warm to 4°C and mix thoroughly. Do not store with fertilizers, seeds, insecticides, fungicides or animal or human food stuffs.

Practical use considerations

1. Good brush control using 2,4-D is completely dependent upon adequate coverage of all foliage, to the point of run off, using a solution mixed to the proper proportions.

2. In the case of aerial application not less than 8 gal/ac (37 L/ac) should be applied to relatively small brush. Improved coverage and improved final kill will be attained if the same swath is treated in two different directions.

3. The addition of 1 to 5 per cent diesel oil to the spray mixture has been suggested if application has to be delayed beyond the optimum season of treatment. Addition of a surfactant to improve the mixing capabilities may be necessary. Initial foliage burn is improved, but any improvement in total kill is uncertain.

2,4-D + 2,4-D P (dichlorprop)

Desormone 7	Diphenoprop 700	Silvaprop 700
Union Carbide	Pfizer	May & Baker

1. FORMULATION: Emulsifiable concentrate of 2,4-D 350 g/L plus dichlorprop 350 g/L. Available in 20 L containers.

2. REGISTERED MIXES: None.

3. CROPS: Industrial areas, roadsides, rights-of-way.

4. WEEDS CONTROLLED: Alder, aspen, birch, buckbrush, elderberry, hazel, honeysuckle, poplar, wild cherry, willow.

5. WEEDS SUPPRESSED: None.

6. WHEN USED: When brush is growing actively.

7. HOW TO APPLY:

With:	Power equipment, knapsack sprayer, aircraft
Rate:	8.5-11.0 L in 1000 L water for stem foliage treatments. Consult label for alternate rates and application methods.
Water Volume:	Use sufficient volume of spray solution to ensure adequate coverage.
Pressure:	275 kPa
Nozzles:	As required to provide good coverage.

8. SPRAYING TIPS:
   (a) Forms an emulsion, agitation is required.
   (b) Good coverage of all foliage is essential.
   (c) May be mixed with oil for basal or stump treatments.

9. HOW IT WORKS: Hormone type herbicide which causes abnormal growth symptoms and affects respiration, food reserves and cell division. Absorbed primarily by leaves and stems and translocated to roots and growing points.

10. EXPECTED RESULTS: Susceptible plants, leaves wilt, turn brown within two to four weeks.

11. EFFECTS OF RAINFALL: Rain within 3 to 4 hours of application may reduce effectiveness.

12. MOVEMENT IN SOIL: No problem from leaching.

13. GRAZING AND CROPPING RESTRICTIONS: Do not allow spray drift over desirable areas of susceptible vegetation. No grazing or seeding restrictions.

14. TOXICITY: Low toxicity to mammals but do not apply when bees are foraging.

15. PRECAUTIONS, FIRST AID: Wear standard protective clothing to reduce exposure. To clean skin or eyes wash copiously with clean water. If swallowed, do not induce vomiting - see a doctor.

16. STORAGE: If frozen warm to 5°C and mix thoroughly. Do not store with seed, fertilizers, insecticides, fungicides or animal or human food.

Practical use considerations

1. See 2,4-D

Banvel (agricultural label)
DyCleer (industrial label) dicamba
Velsicol

1. FORMULATIONS: Banvel LH, DyCleer LH - Solution containing 480 g/L
   DyCleer 2:4 - solution containing dicamba 200 g/L plus 2,4-D 400 g/L
   Banvel 10 G - granular - dicamba 10 per cent

   NOTE:
   1. In 1986, a new formulation of Banvel LH and DyCleer LH, containing **480 g/L of active dicamba** will be introduced. Printed recommendations are for this material. To confirm the formulation being used always check the label.
   2. DyCleer LH and Banvel LH are similar products registered for use in different situations and to control a different range of weeds and brush. To avoid legal complications - read the label to ensure the correct product is used.

2. REGISTERED MIXES: Banvel plus 2,4-D amine or ester. DyCleer plus 2,4-D amine or ester.

3. REGISTERED USES: Banvel is registered for agricultural use only - in pastures, rangeland and agricultural noncrop areas. DyCleer is registered for nonagricultural use, industrial and nonagricultural use, industrial and noncrop land and roadsides and rights-of-way.

4. BRUSH, WEEDS CONTROLLED: Deciduous and coniferous brush and harder to kill annual and perennial weeds (as listed below).

5. WHEN USED: Under active growth conditions.

6. HOW TO APPLY:

   With: Conventional ground operated sprayer

Rate:

Weed and Brush Problems	Banvel LH		2,4-D Amine 500		2,4-D Ester 600	DyCleer or Banvel 10G
Canada thistle Field bindweed Goldenrod Perennial sow-thistle Tansy ragwort	850 mL/ac (2.1 L/ha)	PLUS	900 mL/ac (2.2 L/ha)	OR	PLUS 750 mL/ac (1.85 L/ha)	50 lb/ac
Diffuse and spotted knapweed Poverty weed, Pasture sage, Thyme-leaved spurge	1.86 L/ac (4.6 L/ha)					
Alder Aspen poplar Cherry Rose spp. Western snowberry Wolf willow	1.5 L/ac (3.25 L/ha)	PLUS	1.8 L/ac (4.4 L/ha)	OR	PLUS 1.5 L/ac (3.75 L/ha)	45-62 lb/ac
Balsam poplar, Birch, Balsam fir, Pine, Spruce, Tamarack						

Weed and Brush Problems	DyCleer LH		2,4-D Amine 500		2,4-D Ester 600	DyCleer 24
Canada thistle Field bindweed Goldenrod Perennial sow-thistle Tansy ragwort	950 mL/ac (2.3 L/ha)					2.2 L/ac (5.5 L/ha)
Diffuse and spotted knapweed Poverty weed, Pasture sage, Thyme-leaved spurge	1.86 L/ac (4.6 L/ha)					4.5 L/ac (11.0 L/ha)
Alder Aspen poplar Cherry Rose spp. Western snowberry Wolf willow	2.1 L	Rate per 1000 L water for stem foliage application PLUS	4.0 L	OR	PLUS 3.3 L	5.0 L
Balsam poplar Birch Balsam fir, Pine, Spruce, Tamarack	4.0 L	PLUS	8.0 L	OR	PLUS 6.6 L	10.0 L

Water volume: Label rate specifies 45-180 L/ac. However good coverage of all foliage is essential for good control.
Pressure: 275 kPa.
Nozzles: As required to provide good coverage.

8. SPRAY TIPS:
   (a) Good coverage of all foliage is essential to obtain satisfactory kill.
   (b) Do not treat brush taller than 2m.
   (c) Do not mix with oils.
9. HOW IT WORKS: Is absorbed through leaves and roots and disrupts metabolic and growth processes in the plant.
10. EXPECTED RESULTS: Leaf cupping, stem bending and twisting apparent on weeds within 14 days. Leaf browning and death of stems of brush occurs within the year of application.
11. EFFECT OF RAINFALL: Rain four hours after application will not reduce effectiveness.
12. MOVEMENT IN SOIL: May leach downward and contact feeding roots of trees or shrubs outside target area.
13. GRAZING AND CROPPING RESTRICTIONS: Grazing restrictions are dependent upon the rate of DyCleer applied,
    (a) Meat animals may graze DyCleer treated areas 30 days after treatment with no slaughter restrictions.
    (b) If animals destined for slaughter consume treated vegetation within 30 days of spraying feed an untreated diet for 30 days before slaughter.
    (c) Dairy Animals - see following table:

Rate of DyCleer		**Days Delay Between Treatment and Grazing**
600 mL - 1.1 L/ac	(1.5 - 2.7 L/ha)	7 days
1.1 L - 2.2 L/ac	(2.7 - 5.5 L/ha)	14 days
2.2 L - 4.5 L/ac	(5.5 - 11.0 L/ha)	30 days

14. TOXICITY: Low mammalian toxicity, low toxicity to fish, nontoxic to bees.
15. PRECAUTIONS, FIRST AID: Wear standard protective clothing to reduce exposure. To clear skin or eyes, wash copiously with water. If swallowed, induce vomiting and see a doctor.
16. STORAGE: Freezing will cause crystallization but no activity will be lost if reconstituted.

Practical Use Considerations

1. Good brush control still depends upon coverage of all foliage, but dicamba is also soil active and spray falling on the ground may be picked up by feeding roots as well.
2. Care should be exercised that off-target trees are not killed because of soil activity.
3. Dicamba normally works slowly, the effect of the 2,4-D portion of the mix is first apparent.
4. Granular products may be applied at any time the ground is not frozen, but do require moisture for activation.
5. Banvel and Dycleer are similar products registered for use in different situations and with a different list of weeds and brush controlled. Always check the label to ensure that the application is legal.
6. Because of the difficulty in assessing the gallonage of spray solution required to treat one acre of varying density and size of brush, mixing instructions may appear as litres of concentrate per 1000 litres of water. Instructions will read -cover foliage and stem surfaces thoroughly.
7. All application on brush should cease at least 3 weeks prior to change of leaf color in the fall.
8. Use of a tank mix with 2,4-D ester may improve kill of balsam poplar when under drought stress in periods of hot, dry weather.

TORDON (picloram)

Dow

NOTE: *Available only to approved licensed applicators.*

1. FORMULATIONS: Tordon 10 K pellets - 10 per cent picloram - granules
   Tordon 22 K -240 g/L potassium salt of picloram solution
   Tordon 101 - 60 g/L amine salt of picloram + 240 g/L amine salt of 2,4-D solution

2. REGISTERED MIXES: None.

3. REGISTERED USES: **Tordon 10 K** - brush control in nonagricultural, industrial situations. **Tordon 22 K** - control of deep rooted perennial weeds on restricted areas of **agricultural land** under the direct supervision of a licensed applicator. **Tordon 101** - control of weeds and brush on rights-of-way, and industrial sites.

4. WEEDS CONTROLLED: Most brush species and broad leaved weeds. *(See table on pages 14-15)*

5. WHEN USED: Tordon 10 K - applied to soil surface anytime soil is clear of snow and not frozen.
   Tordon 22 K and Tordon 101 - apply any time leaves are fully expanded in the spring up until about three weeks prior to a killing frost.

6. HOW TO APPLY:

With:	Tordon 10 K - hand or ground operated or aerial pellet spreader.
	Tordon 22 K - hand or ground operated sprayer.
	Tordon 101 - ground operated sprayer or a helicopter, using a drift control agent.
Rate:	Tordon 10 K pellets - 16-38 kg/ac (40-95 kg/ha) depending upon species of weeds and brush.
	Tordon 22 K - 450 mL - 3.6 L/ac (1.1 -9.0 L/ha) depending upon species of weeds.
	Tordon 101 - Weed control - 3.8 L/ac (7 L/ha) brush control - 10.0 L in 1000 L of water.
Water Volume:	Use 80-800 L/ac (200 - 2000 L/ha) of water depending upon growth density.
Pressure:	300 kPa to apply 80 L/ac (200 L/ha) and reduce for higher rates.

8. SPRAYING TIPS: Tordon 10 K pellets must be spread evenly over the soil surface. Higher rates may injure the grass if applied in drier areas of the province. Tordon 22 K, used as a spot treatment in a crop, should not exceed 1 ac (.4 ha), and the total area treated in any one year should not exceed 5 per cent of the total acreage.

   NOTE: *Picloram is extremely persistent and water soluble and small quantities may cause damage to desirable plants. Do not allow contamination of soil used to grow desirable plants. Do not contaminate water used for irrigation or domestic purposes.*

9. HOW IT WORKS: Tordon interferes with cell division, causing leaf cupping, stem distortion and eventually death of the plant. Absorbed through leaves and roots.

10. EXPECTED RESULTS: Tordon 10 K Pellets - Rainfall is necessary to activate this formulation. Two or three weeks after rainfall leaves of susceptible growth become dull and cupped, and orange streaks appear on the bark of poplars. Susceptible species die slowly. Tordon 101 Mixture - Above symptoms become apparent two or three weeks after application. Tordon 22 K Herbicide - Susceptible perennial weeds show stem twisting and leaf cupping and die. Because of decreased competition grass may increase.

11. EFFECT OF RAINFALL: Heavy rainfall may carry the chemical away from the target area, particularly on light sandy soil, and reduce effectiveness or cause some off-target injury.

12. MOVEMENT IN SOIL: Picloram is very water soluble and will move readily in soil water.

13. GRAZING AND CROPPING RESTRICTIONS: Manure from animals grazing in picloram treated vegetation should not be used on ground where sensitive crops are grown. It should be used on a field destined for cereal crop production. When used as a spot treatment in a cultivated field, picloram may persist for up to five years and prevent the establishment of sensitive crops. In a normal rotational system - first year after a Tordon treatment seed oats or rapeseed. Second year: seed oats, rapeseed or barley. Third year: seed oats, rapeseed, barley or wheat. There may be a yield reduction in the first year caused by the Tordon, but usually

this is offset by an increased yield because of better weed control.

Legumes cannot be established for up to five years following a Tordon treatment.

14. TOXICITY: Very low acute mammalian toxicity. Oral LD_{50} - rats - technical picloram 8200 mg/kg
    Tordon 10 K Pellets - 10,300 mg/kg
    Tordon 101 Mixture - 8,000 mg/kg
15. PRECAUTIONS, FIRST AID: Wear standard protective clothing when applying the herbicide. If skin or eyes are contaminated wash copiously with water.
16. STORAGE: Tordon 10 K pellets - Store in a cool dry location. Tordon 22 K and Tordon 101 Mixture - Do not freeze. If frozen, warm and mix thoroughly.

KRENITE (fosamine)

DuPont

1. FORMULATIONS: Solution containing 480 g/L - 10 L pack.
2. REGISTERED MIXES: Krenite + nonionic surfactant.
3. CROPS: Brush control on noncropland.
4. WEEDS CONTROLLED: Brush species - ash, birch, trembling aspen, pine, white spruce.
5. WEEDS SUPPRESSED: None.
6. WHEN USED: Between mid-June and late July.
7. HOW TO APPLY:

With:	High volume, ground equipment
Rate:	Use 10.0 - 15.0 L/1000 L of water and add 1 - 2 L of surfactant to the mixture. Use the higher rate on white spruce.
Water Volume:	Apply to point of run-off. Probably 200 - 2000 L/ac (500 - 3000 L/ha) of spray solution.

8. SPRAYING TIPS: Do not apply to food crops. The use of a nonionic surfactant is required to control white spruce and will greatly enhance the control of root suckering deciduous brush.
9. HOW IT WORKS: The chemical is absorbed by the leaves, stems and buds and will restrict the development of buds the following spring.
10. EXPECTED RESULTS: Injury may not be apparent until the following spring, particularly if the lower rates are used, or if weather is cool following spraying.

    Plants fail to develop leaves the following spring and subsequently die.
11. EFFECTS OF RAINFALL: Rainfall within 24 hours of application may reduce effectiveness.
12. MOVEMENT IN SOIL: Krenite is readily adsorbed to soil colloids so there is little downward movement.
13. GRAZING AND CROPPING RESTRICTIONS: Do not graze on land treated with Krenite.
14. TOXICITY: Very low acute mammalian toxicity - oral LD_{50} - rats - 20,000 mg/kg, nontoxic to birds and fish.
15. PRECAUTIONS, FIRST AID: Wear standard protective clothing to reduce contamination. If skin or eyes are affected wash copiously with water. If swallowed, induce vomiting and get medical aid.
16. STORAGE: Store in a cool dry place.

Practical use considerations

1. This product has attained wide use only in environmentally sensitive locations.
2. Commercial applications are not popular, since there is such a long delay after application before results may be apparent. The usual action on the part of a customer is to wait until results can be assessed before authorizing payment.